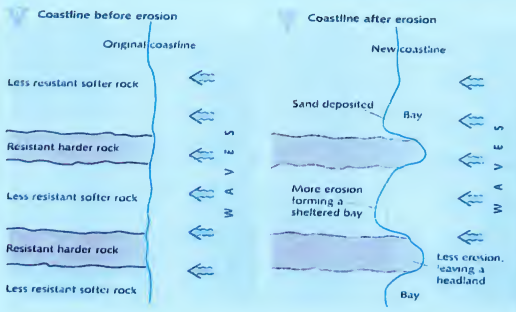
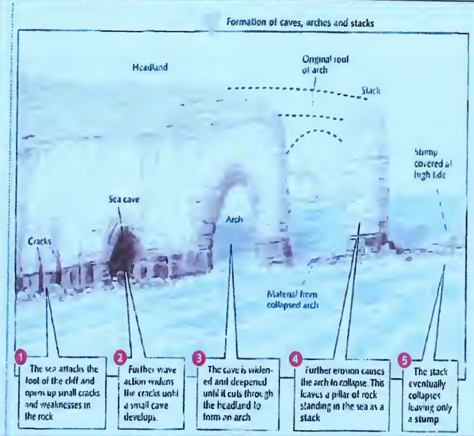
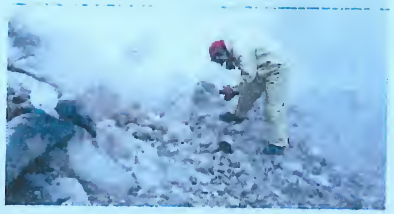
Theme 2.1 – Coasts and coastal management

Erosional coastal processes- Holderness coast, NE England

Landforms of erosion – Headlands and bays







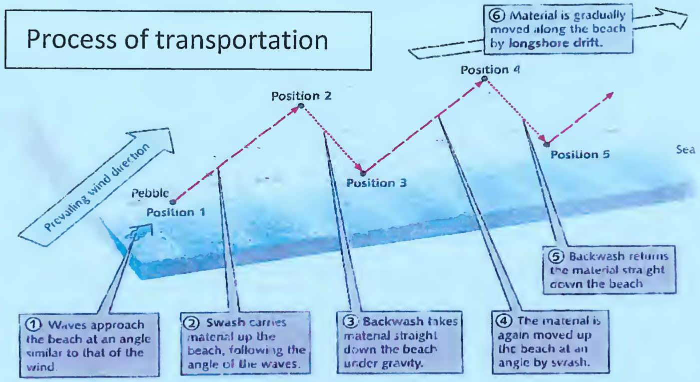
- Due to destructive waves the coastline is **eroded**, by **hydraulic action** and **abrasion.**
- **Soft** rock erodes **quicker** and **retreats.**
- The hard rock **remains** and forms headlands.
- Due to **attrition** the eroded rock is broken down to form **sand** and then **deposited** in the bay.

Key words relating to this case study:

Name	Description
Abrasion	As waves smash rocks against cliff surfaces, they are worn away and become smoother. This is known as the "sandpaper effect".
Hydraulic power	Air becomes trapped in faults in cliffs. When waves break against the cliffs, the air is compressed and forces the fault to become bigger. This eventually causes a piece of the cliff to break away.
Solution	Acids in sea water dissolve certain types of rock, such as limestone or chalk, causing them to gradually erode over time.
Attrition	Material from the coastline collides with other material, breaking into smaller pieces.
Freeze-thaw weathering	Water collects in faults during the day. At night, this water freezes and expands. This makes faults bigger over time and is similar to hydraulic power.

Depositional coastal processes/ landforms

Process of transportation



Depositional landform eg SPURN POINT

1 Sand and shingle are deposited in water which is sheltered by the headland.

2 Material builds up and outwards, forming a spit.

3 A change in wind direction causes the waves to change direction. The end of the spit is made to curve.

4 The shallow, sheltered area behind the spit fills with mud. This is called a salt marsh.

Depositional landform(s)

Landforms of deposition –Bars and Tombolos

If there is **no river** running into the sea where the spit has formed, it could become a **BAR** and stretch all the way across. Behind the bar is a **Lagoon** which in time may become a **Salt Marsh.**

If the material reaches an offshore island it is a **TOMBOLO.**

Holderness- Fact File

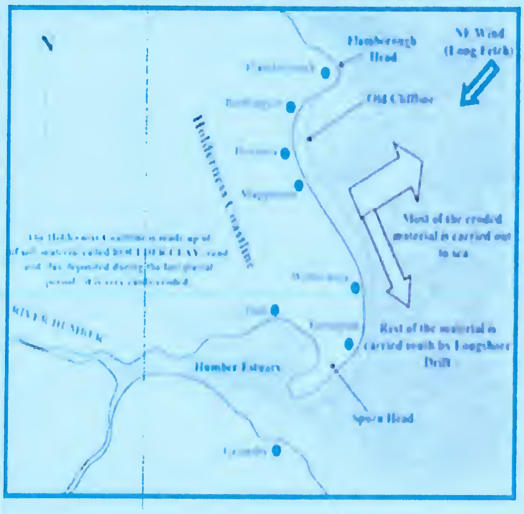
- **61 km long**- it stretches from Flamborough Head (Chalk Headland) to Spurn Head (a spit)
- Erosion is causing the cliffs made of **boulder clay** (SOFT rock) to collapse along the coastline and eroded material is transported south to form the depositional landform Spurn Head.
- About **1.8 m** of land is lost to the sea every year- in some places e.g Great Cowden, the rate of erosion has been over **10m per year in recent years (100m or equivalent in 10 years)!**

Landforms:

Erosional landform - To the **north** of the Holderness Coastline is ***Flamborough Head***. This **Chalk headland** is more **resistant** to erosion and therefore juts out into the North Sea. A the base of the headland a **wave cut platform** has been created by the process of **hydraulic action** and **abrasion**, there are also various **caves, arches and stacks** created in these chalk cliffs.

Depositional landform - To the south of the Holderness coastline is **Spurn Head**. A sand spit caused by **deposition** of eroded material carried by **longshore drift** from the boulder clay cliffs to the north. The spit was created because the **Humber Estuary** caused the **coastline to change direction**. Eroded material is continually deposited in the shallow waters across the Humber and the spit extends. A re-curved end is formed by a temporary change in in wind direction.

The Holderness Coastline: Coastal Erosion and Defence



Reasons for the rapid erosion

- Easily eroded rock type- the cliffs are mostly made up of **boulder clay** which is easily eroded. It's likely to slump when it's wet causing the cliffs to collapse.
- Naturally **narrow beaches**- beaches slow waves down reducing their erosive power so the narrow beach gives less protection
- People worsening the situation- **coastal defences** called groynes have been built at Mappleton. Groynes stop material from being moved further down the coast. The means that the beaches are narrower in some places.
- **Powerful waves**- Holderness faces the prevailing wind direction, which brings the waves from the north east. The coast is battered by destructive waves.

Impact on people's lives.

- Homes near the cliffs in Skipsea are at risk of collapsing into the sea.
- Property prices along the coast have fallen sharply for those houses at risk from erosion.
- Accessibility to some settlements has been affected because roads near the cliff tops are at risk of collapsing into the sea.
- Businesses are at risk from erosion so people will lose their jobs eg. Seaside Caravan Park at Ulrome is losing an average of 10 pitches a year.
- The gas terminal at Easington is at risk (it's only 25m from the cliff edge). This terminal accounts for 25% OF Britain's gas supply)
- 80,000m2 of farmland is lost each year. This has a huge effect on farmers' livelihoods.

Environmental impacts

- Some SSSI's (Sites of Special Scientific Interest) are threatened Lagoons near Easington are separated from the sea by a narrow strip of sand and shingle (a bar). If this is eroded it will connect the Lagoons to the sea and they would be destroyed.

Management: Village: Mappleton: A **Hard engineering strategy:**
In 1991 £2 million was spent on coastal protection scheme at Mappleton to reduce coastal erosion,

What are they doing about it?

Built 2 boulder groynes at right angles to the beach to intercept (catch) beach material moving south down the coast from LONGSHORE DRIFT .

This helps build up a wide beach which slows the waves down due to friction, and reduces their power to erode the cliffs.

Put granite boulders (Rip Rap) along the base of the cliff to prevent any undercutting by waves which do manage to cross the wide beach.

Seeded the cliff face with grass so it is less likely to be eroded by heavy rain.

Landscaped the cliff face to a gentler angle so it is less likely to SLUMP from heavy rain.

Management: Evaluation

Successful Outcomes of the Mappleton Defences

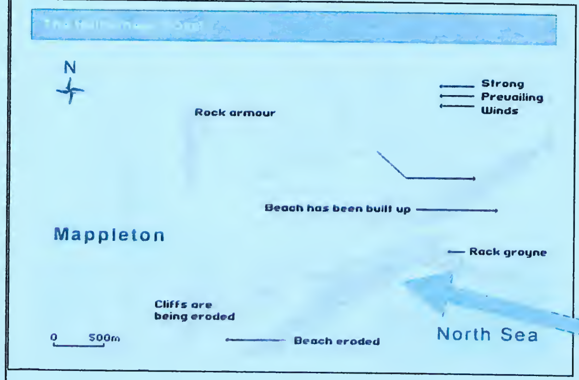
Erosion has been **effectively** stopped behind the defences. The grass growing on the landscaped cliffs shows they are no longer 'active' – in contrast to the cliffs down coast. The road has been 'saved' – along with the village.

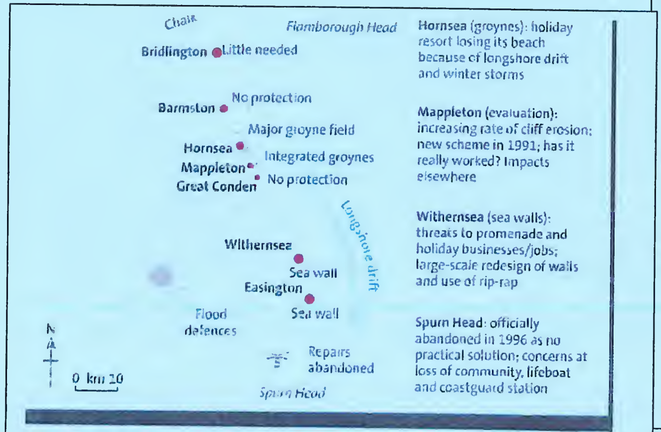
Tourism in the area has increased as a result of the wider beach and the interest in the scheme.

Less Successful Outcomes of the Mappleton Defences

- Erosion has increased down coast. Material moved by Longshore Drift is successfully 'trapped' at Mappleton by the rock groynes – but this means it is not moving down the coast to accumulate on beaches there. As a result beaches south of Mappleton are robbed of sand, becoming narrower and erosion is faster than it used to be before the scheme
- Other villages under threat of coastal erosion say that a precedent has been set – and their villages should now be protected like Mappleton – otherwise it is unfair.
- Erosion is still taking place north of Mappleton, so in the future the protected area is likely to become a peninsula as the coast to the north and south retreats westward. So more money will have to be spent protecting the sides of it.

Management of coastline- Holderness coast, NE England





__Background__
- Holderness coast is in **Humberside**, North East England.
- Suffers one of the fastest rates of erosion in world.
- Loses around **1-2 metres of coastline per year.**
- Mappleton is now in danger of falling into the sea.
- **29 villages lost** from coastline since roman times.

__Cause__
- **Soft rock**, made of **till** which contains small pebbles and clay
- Very strong waves (MAINLY DESTRUCTIVE)

__Response__
- **£2 million spent** on **rock groynes** at Mappleton and **rip-rap.**
- They spent this money as they did not want to **re-route the Hornsea to Withensea road**, which would have been expensive to do.

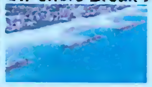
__Effects__
__POSITIVE:__
- Has stopped erosion at Mappleton, as it now has a beach protecting the foot of the cliff.

__NEGATIVE:__
- Further **south has no beach**, as the groynes have stopped longshore drift taking beach material further down the coast.
- Sue Earl who owned Cliff Top farm saw erosion increase from **1 metre a year to 20 metres a year** in certain places.
- Sue Earl's farm has now been demolished, and she had to live in a caravan. Sue Earl blames the Sea defences at Mappleton for causing the increased erosion near her farm, and is trying to sue the local council.

THIS MANAGEMENT DOES NOT TACKLE THE ADDITIONAL ISSUE OF SLUMPING (CAUSED BY SUB-AERIAL EROSION)

Management of coastline- Hard Verses Soft engineering

Hard Engineering:

Groynes 	• Stops Longshore Drift = beach. • Wooden posts out to sea. • ***No beach further down coast = more erosion.***
Gabions 	• Stones in mesh cages. • Waves energy is dispersed through them • ***Look ugly and are a danger for animals e.g birds.***
Sea Wall 	• Concrete Wall – reflects waves energy. • ***Can increase wave backwash meaning the beach is removed.*** • ***Ugly, expensive, graffiti.***
Off-Shore Break Water 	• A build up of rocks out at sea. • Disperses waves energy out at sea. • Beach builds up behind them as there is little sea current. • ***Ugly, expensive, dangerous – children.***
Revetments 	• Sloping concrete / wooden platform. • Allows wave energy to be dispersed as it travels up the revetment. • ***Ugly, expensive.***

CONSIDERED LESS SUSTAINABLE

Possible questions – could be worth 6 or 9 marks.

You may be expected to compare the =/- of hard and soft management strategies.

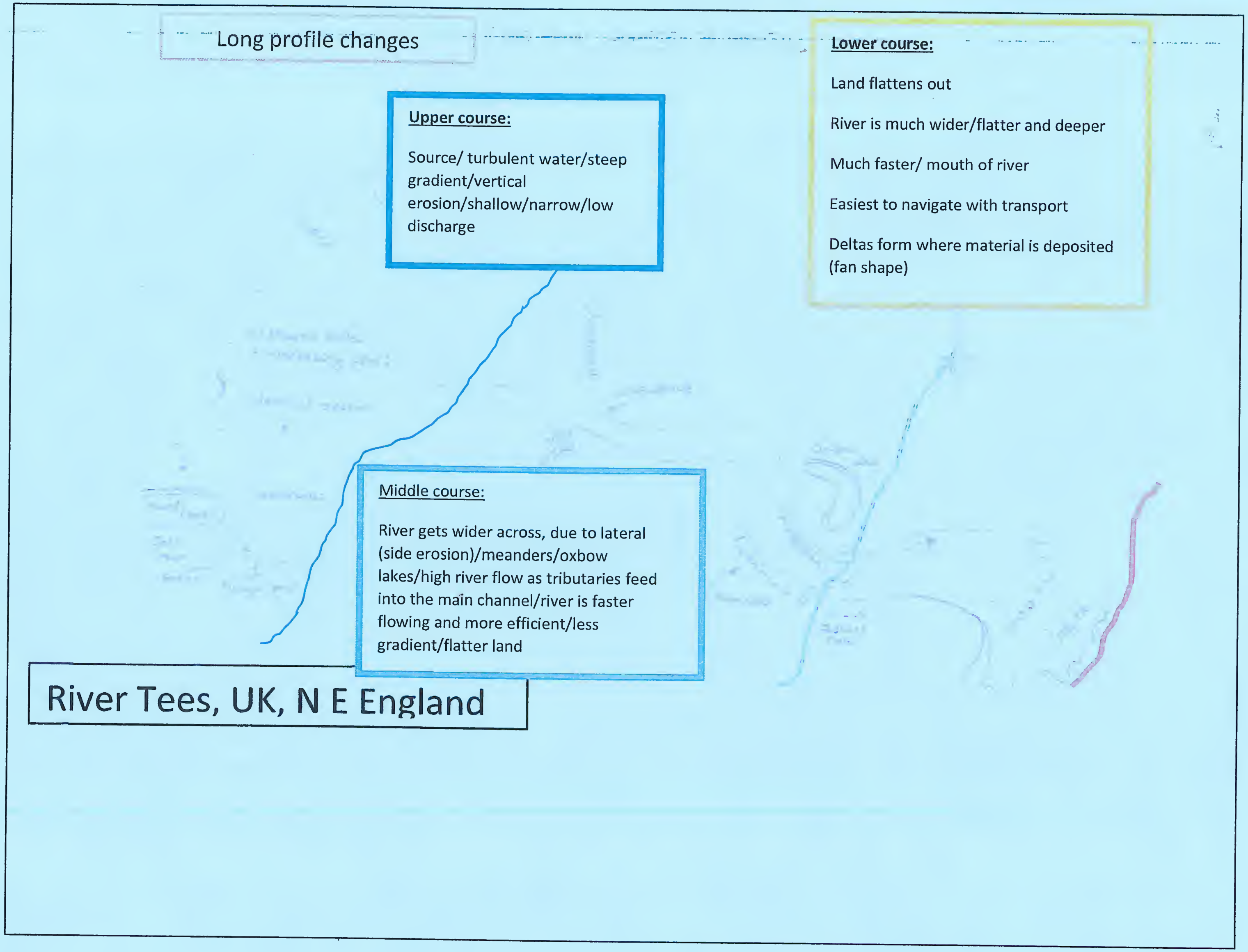
Soft Engineering:

1. **Beach Nourishment** – which means placing sand in front of the eroding coast.
2. **Managed Retreats** – Let the coast erode naturally and move the people and businesses away slowly.
3. **Cliff Drainage** - Pipes which allow wet cliffs to drain the heavy rain water away.

CONSIDERED MORE SUSTAINABLE

Theme 2.2 –Rivers and river management

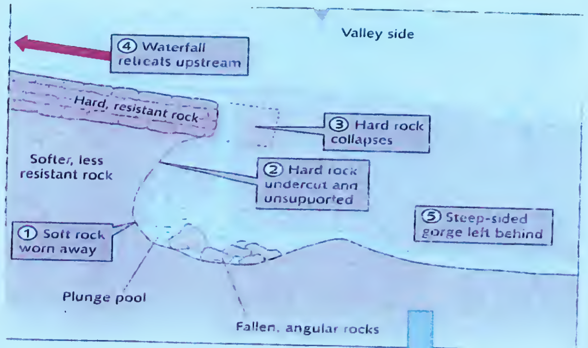
DESCRIBE (AO1)/ EXPLAIN (A02)- When asked to describe changes in the long profile of a river, refer to the gradient, river bed depth and width and types of erosion. Link landforms to the appropriate course. You may also be asked about how human activity varies in each location (ie) provide reasons.



Oxbow lake: An isolated horseshoe-shaped bend that forms when two outside bends of a meander meet. Over time this will dry out and will fill with vegetation.

High Force WATERFALL, River Tees, NE England – A RIVER LANDFORM FOUND IN THE UPPER COURSE

Upper course feature – Waterfall

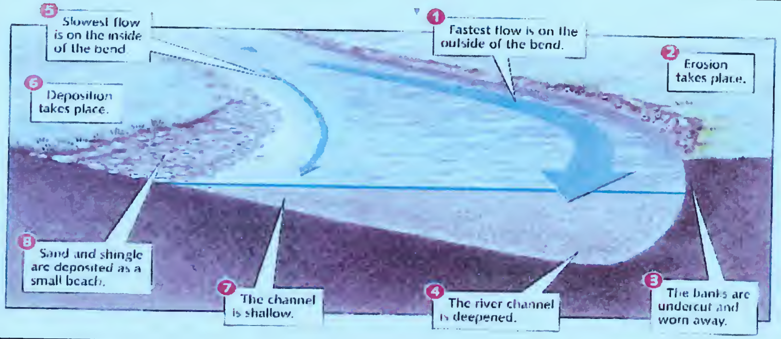


Understanding: You will not be expected to evaluate. Your point, develop will be important and using staging and key words. A waterfall moves further towards the source of the river over time.

Waterfalls can be important for the economy, as tourists may visit.

Meander, River Tees, NE England – A RIVER LANDFORM FOUND IN THE MIDDLE COURSE

Meanders are constantly changing shape and position. They are eroding in a **lateral** direction (across).
- **Deposition** happens on **inside** slow part of bend = **Slip Off** Slope
- **Erosion** happens on outside fast part of the bend (hydraulic action, abrasion), creating **a river cliff.**



Understanding: You will not be expected to evaluate. Your point, develop will be important and using staging and key words. Meanders can often be found near farmland or on flood plains. Over time a meander can form into an **OXBOW LAKE.***

The Hydrologic Cycle

Rivers Knowledge Organiser.

The drainage basin is the area of land drained by a river and it's tributaries. Its boundary is the *watershed*. The start of a river is called the *source*, and the end of the river as it enters the sea is the *mouth*. The main river channel may be joined by smaller rivers called *tributaries,* and this meeting point is called a *confluence*.

Erosion in a river has a number of different forms.

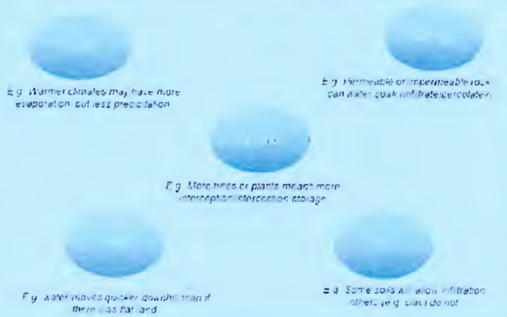
- Attrition is the 'smashing' of sediment against each other to become more rounded.
- Hydraulic action is the sheer force of the water breaking down the river banks and bed.
- Corrosion (solution) is the dissolving of material.
- Abrasion (corasion) is the action of sediment scraping against the bed and bank of the river (like sandpaper).

The hydrological cycle is a closed system. This means that water never leaves, or enters the cycle of water from sea, land and atmosphere.
The cycle is important because it shows us how water can enter the drainage basin, and how water can be responsible for increasing or decreasing our risk of flooding.
Key words include:

- Precipitation – water entering the land through rain, snow, sleet and hail.
- Evaporation – the process of water turning from a liquid in to water vapour as it is warmed.
- Transpiration – the loss of water from trees and plants
- Condensation – water vapour returning to a liquid once cooled.
- Interception – water being trapped by tree leaves and plant leaves
- Surface run off – water travelling **over** the land.
- Infiltration – water soaking into the soil.
- Throughflow – water flowing downhill in the soil.
- Percolation – water passing vertically through soil and rock
- Groundwater flow – water flowing vertically through rock.
- Channel flow – water flowing in a river channel
- Channel storage – water being stored in the river.

Some factors will influence the way that water travels to the river – see below.

Factors influencing the hydrological cycle- what speeds it up, or slows it down?

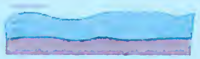


Hydrographs are a method to show us the relationship between rainfall and discharge (the amount of water in the river at a given time).
Hydrographs can help us to predict the risk of flooding, but also can help us to understand how water has made it's way the river...

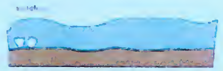
Transportation.

- Transportation happens in one of four ways:
- As solution: dissolved minerals carried in the water.

- Suspension: Small particles of rock and soil are carried along – they make the water look cloudy or muddy.

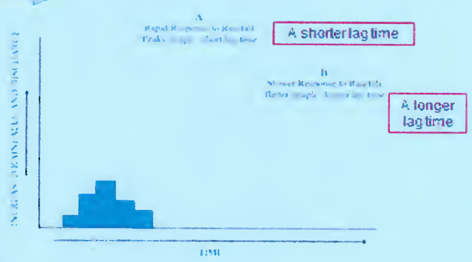


- As **saltation:** sand grains and small stones just bounce along.



- As **traction**: Larger stones and rocks get rolled along.

The **lag time** of a hydrograph is the time between the peak rainfall and the peak discharge. If this is long (e.g. b) then it means water will have infiltrated rather than moved through surface run off, as surface run off would cause water to enter the river quickly, and so our hydrograph would have a shorter lag time (e.g. a).



Rivers flooding can be caused by a number of factors.
These could be human factors:

- Farming – ploughing can cause water to collect in the troughs and run directly in to the river.
- Urbanisation – building with tarmac and concrete does not allow infiltration so water moves to the river through surface run off, or might sit on the land.
- Disappearing fields – similarly to urbanisation, this means that infiltration is reduced, and surface run off increases.
- Deforestation - cutting down trees will reduce interception storage and increase surface run off.

Or physical factors:

- Weather and climate: hotter weather increases evaporation which will then decrease the amount of discharge. Colder weather will cause more surface run off as frozen ground cannot infiltrate water.
- High amounts of rainfall – saturated ground will not infiltrate further rainfall, which increases surface run off, and therefore the discharge in the river.
- Steep land – steep land increases surface run off and therefore the discharge in the river.

River flooding might bring a lot of effects to an area. They are worse in LICs as the countries are unable to prepare, or protect.
These impacts can be social, economic or environmental.

Social: loss of homes, death, loss of possessions etc.

Economic: Cost of repairs, loss of income from flooded farmland, loss of business, loss of jobs etc.

Environmental: Damaged habitats, destroyed land, contaminated water sources etc.

Rivers flooding can be managed using two different strategies.
For each strategy you would be expected to explain why it is effective (and sustainable) economically, environmentally and socially.
E.g. Hard engineering strategies such as a dam are effective socially as the can reduce flooding, but economically they can cost a lot, and environmentally they can change the habitats of animals and plants.

Hard engineering.

- Man made structures built to control the flow of rivers and reduce flooding.

Flood walls

Dams

Embankments

Soft engineering.

- Soft engineering strategies are schemes set up using knowledge about a river and its processes to reduce the effects of flooding.

Afforestation

Warning systems

Washlands - floodplains

Banbury Floods:

Banbury is located in the Cotswolds, north of Oxford.

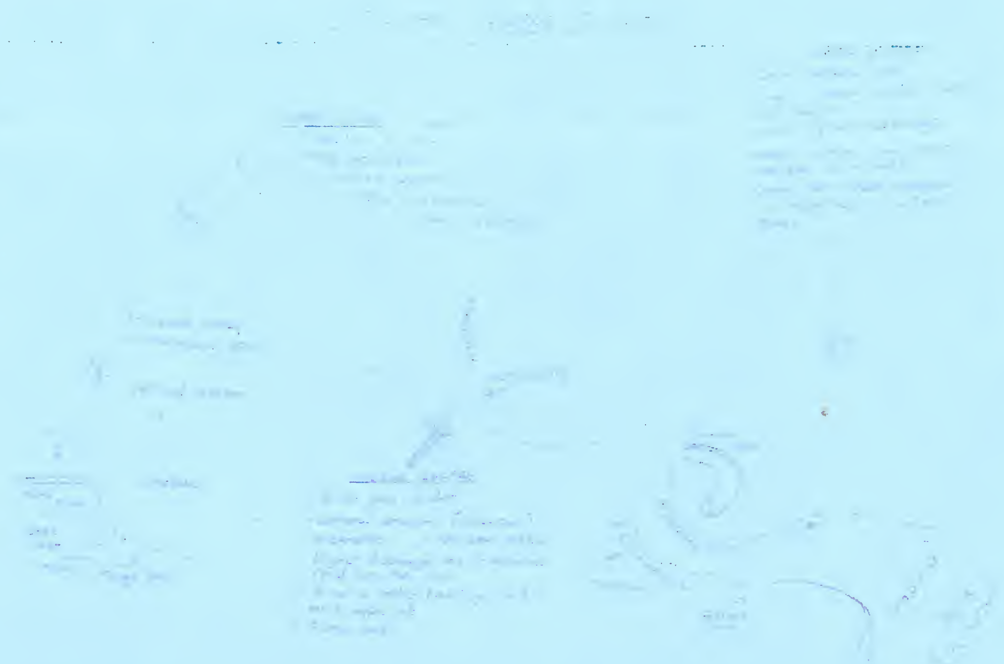
Impacts of flooding:
In 1998 flooding led to the closure of the railway station, local roads and caused £12.5m damage. More than 150 homes and businesses were affected. In 2007 these impacts were repeated.

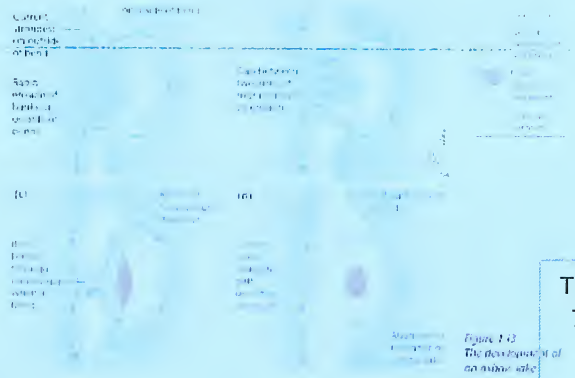
What has been done to reduce flooding?

- A361 raised, and drainage below the road improved.
- Earth embankments built.
- Floodwalls built.
- Pumping station to transfer excess water.
- Creation of new Biodiversity Action Plan to allow nature to 'soak' up excess water.

What were the costs/benefits?
Socially: quality of life has improved, reduced levels of anxiety of flooding, the A361 will no longer need to be closed.
Economically: Cost £18.5m, but benefits of protecting are over £100m!
Environmentally: Small reservoir created from earth taken for embankments, new Biodiversity Action Plan has created new habitats, and floodplain protected for flooding.

River Tees





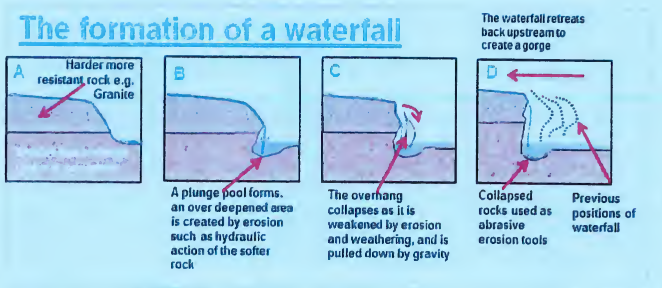
The river is 85 miles long, and drains an area of 710 square miles. Its source is in the Pennine hills, and flows in to the North Sea at Middlesbrough.

Upper course: The upper course of the river has impressive waterfalls. The river drops 20m in a single sheet of water – High Force Waterfall (tallest in England). The waterfall has retreated back overtime to form a gorge. There are high v-shaped valleys, and interlocking spurs in the upper course of the river.

The river has been straightened and widened over time to allow navigation for industry and trade.

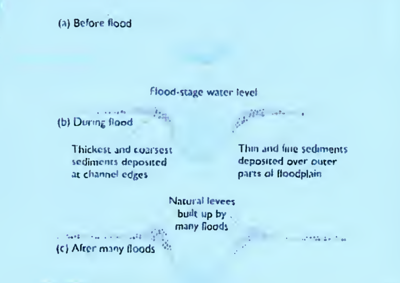
Middle/lower course: There are good examples of meanders, levees and floodplains along the River Tees. The natural levees have built up over time as the river floods and sediment is deposited on the banks of the river. There are large industries in the lower course of the river, making the most of the flat land and river's flow in to the North Sea. This area of the river needs high levels of management. In Yarn there are extensive flood protection methods.

The image above tracks the journey of a river from source to mouth. Note that the river starts on high land, and meets the sea on flat land.
The features of a river will change from source to mouth. This is due to erosion and transportation of material. Typically larger material is found in the upper course of a river, and the material reduces in size as it makes it way to the mouth.
Erosion will change from vertical (downwards) to horizontal erosion.



A waterfall will form when bands of hard and soft rock lie on top of each other. Over time the hard (more resistant) rock will be eroded, and therefore the soft rock will be eroded vertically. This creates a plunge pool – and overtime the waterfall will retreat backwards creating a gorge.

Formation of Natural Levees

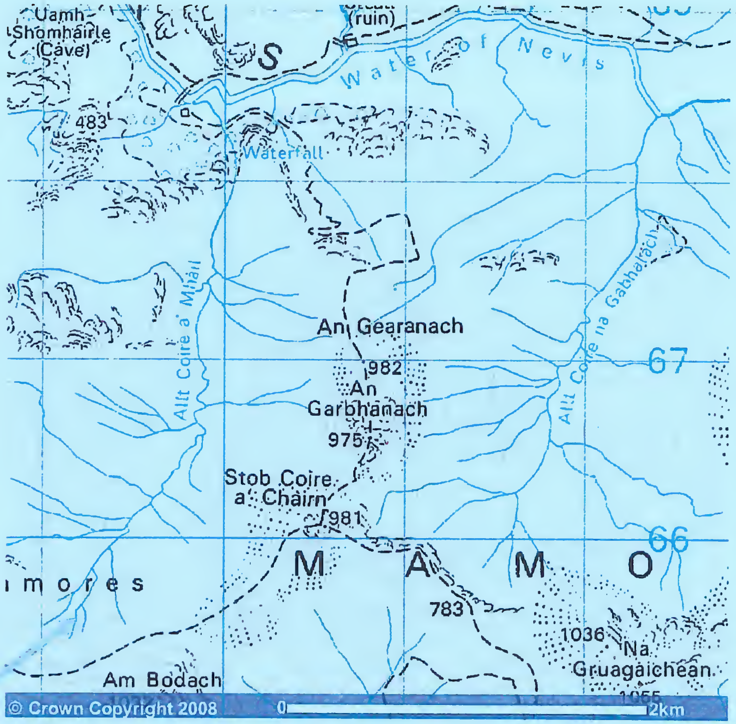


Rivers on a map:

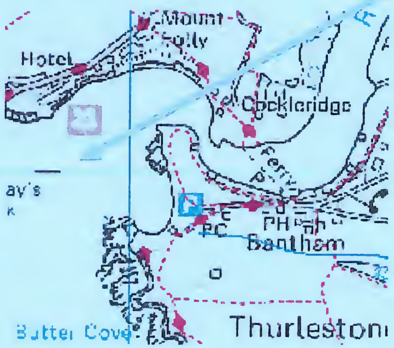
Figure 13

You will often be asked exam questions using OS map extracts for rivers.

Using the map above we can identify a number of features about a river. This map shows us clear meanders (e.g. 46, 54), and flat land (lack of contour lines either side of the river on the map).



This map extract clearly shows high land – look at the contour lines, and the high numbers!
This would suggest it is the upper course of the river – the water falls labelled is also clear evidence of the upper course of the river.



This extract clearly shows the mouth of the river as the river meets the sea.

Theme 2.3 –Weather and climate

A03 Severity- This is one of the strongest storms ever recorded. The low lying islands and the 5, storm surge left communities helpless and despite hurricane early warning systems, evacuation was impossible by the authorities of so many people living in remote islands. Poor quality buildings and poverty, meant the death toll was almost 7000.The social impacts of this event were considerable and the economy suffered in the short and long term. The response was effective and long term investment has focused on safety in a future storm.

Typhoon Haiyan –a tropical storm – Philippines, Nov 2013

Background

'Super Typhoon Haiyan'- a category five storm (Saffir Simpson scale)- Nov 2013, hit the Philippines (a series of low lying islands).

Cause- Very low atmospheric pressure linked to the typhoon caused the level of the sea to rise. As the stong winds swept this onshore, it formed a water of water 3 -5 m high).

Impacts/ Effects: Social Economic Environmental, Political

Primary effects (impacts of strong winds/heavy rain/storm surge)	Secondary effects (longer term impacts resulting from primary effects)
Approx 6300 dead, mostly drowned by the storm surge.	14 million affected, with many left homeless and 6 million lost their source of income.
600 000 displaced 40 000 homes damaged or flattened	Flooding led to landslides and blocked roads, cutting off aid to remote communities and power supply off for a month.
Tacloban airport terminal damaged	Aid efforts slowed as transport, such as ferries and airline flights were disrupted for weeks.
300 000 fishing boats destroyed, alongside damaged buildings/ power lines and destroyed crops	Shortages of water, food and shelter affected many people, leading to outbreaks of disease. Many jobs lost, hospitals damaged / schools destroyed, affecting livelihoods and education.
400 mm of rain caused widespread flooding	*Looting and violence **broke out in the worst affected Tacloban -200 000 homeless)***

Link – Death toll wise, **primary effects** were instant and the biggest contributing factor was poverty and lack of **preparedness.**

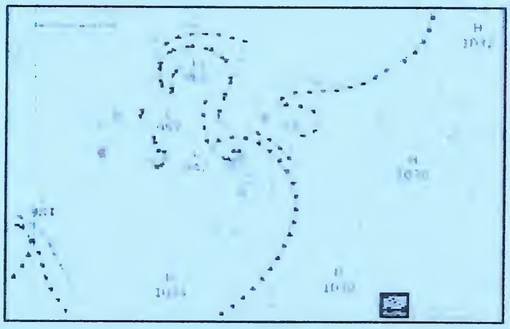
Responses: Develop points Immediate	Long-term Develop points
Quick response from international government and aid agencies (in the form of food, water and temporary shelters. This saved lives and reduced further risk.	Financial aid and medical supplies donated by HIC governments, which meant deaths from disease were reduced.
US helicopters assisted with search and rescue and the delivery of aid/ **1200** evacuation centres were set up to help the homeless and reduce the death toll.	The economy was restarted via rebuilding of infrastructure programmes/ new livelihood community projects/ cash for work programmes, in order to clear the debris. This empowered the local people. Cyclone shelters built to reduce risk in a repeat event.
Food aid was sent by the Philippines Red Cross (basic and non-perishable)/ UK sent shelter kits.	New homes built away from flooding risk/ higher ground/ charities replaced fishing boats eg Oxfam, so people felt safer and could return to normal.

3,000 acres of land near Clear Lake burnt out of control.	Cars abandoned on Interstate 15 when a wildfire swept across the road.
People were evacuated from their homes	Most HEP dams stopped producing electricity.
In the summer heat, moisture from the soil evaporated and vegetation died.	Farmers in Central Valley lost $810 million during 2015.
Homeowners were told to stop using water to wash their drives or water gardens. Using a hosepipe to wash cars was banned.	Discharge of the rivers fell to lower than normal levels. August 2015, 44% of rivers had flows that were 10% of their normal flow.
Cracks appeared in buildings and roads due to subsistence. (Water was pumped out of the ground faster than it was being replaced).	Salmon and trout died in the San Joaquin River Delta. An increase in river temperature means the water carries less oxygen for fish.
California usually produces nearly half of the fruits and vegetables grown in the USA. Shortages meant prices rose by 6% in the shops. More food was imported.	The state government paid $687 million of its savings to compensate farmers and homeowners who lost earnings or property. This money could have been used for other much needed projects.
36% increase in wildfires. Property was damaged and wildlife killed. 31,000 acres of oak habitat was burnt.	The state lost 17,100 agricultural jobs due to the drought.

California High pressure event – drought (HIC)

Theme 2.4 –Climate change

United Kingdom 2013- Extreme Weather



Causes of the 2013 winter storms

The main cause of the 2013 storms was a deep depression which formed over the Atlantic Ocean. On four occasions the pressure reached 950mb which is extremely low. On 24th December it reached 936mb which is the lowest it has been since 1886. The reason for this low pressure was the temperature was 1.5 degrees warmer than average and this contrasted with the bitterly cold temperatures from the north.

Impacts of the 2013 winter storms		
Social	**Economic**	**Environmental**
25% of the damage was caused to residential properties. Nearly 600 residents were evacuated from their homes in Boston, Lincolnshire due to coastal flooding. 50,000 homes in Dorset, Kent and Surrey lost power after power lines were damaged. A teenager died in Devon after being swept away by a wave.	£1.3 billion worth of economic damage. £19 million loss to the agricultural industry through damage to crops. £180 million damage to roads and £110 million damage to rail ways through damage to tracks and disrupted service.	The coastal surge in Norfolk destroyed large areas of important coastal habitat. Affecting wildlife in those areas. A landmark rock arch in Porthcothan, Cornwall collapsed. Landlips happened along the east coast of the UK.

Responses to the 2013 winter storms

National scale:
- **UK's COBRA committee met twice to discuss plans for responding to the storms**
- **Environment Agency issued 40 UK wide weather warnings**

Regional scale:
- **Local emergency services were in operation throughout the period to minimise impacts of the storms.**
- **Emergency shelters were set up for those who were evacuated**
- **Somerset declared a 'major incident' during the floods to request support from the military.**
- **The government allocated £100million to repair damage and prevent damage from flooding in future**

Uruguay
Case Study of Renewable Energy

Location - Uruguay is located in South America and is on the East coast. It is classed as a NEE – the GNI is US$4,300.
Uruguay gets **94.5% of its electricity from renewable sources.**
In 2013 the government **invested over US$1.2million** into renewable energy, **over 80%** of the money was invested in **wind energy.**
The country has the **perfect climate for wind energy.** The Atlantic ocean is East to the country and the relief is varying, hills are perfect to capture wind energy.

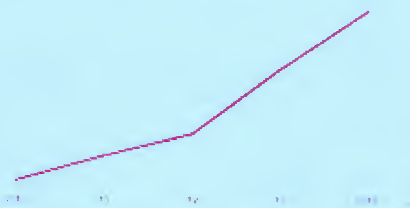
Wind Farm Peralta by Palmatir Wind Power

This is a new project in the **central** part of Uruguay, in the **Province of Tacuarembo .**
It was built in **July 2013 and officially opened in 2014.**
The project consists of **25 turbines**
The energy produced at the Wind Farm will be transported to the national grid through a High Tension Line.
It provides enough electricity for **74,000 people,** which is **2% of the population.**

Advantages

-This wind farm is **reducing the CO2 emissions by 815,862 tons**
The company had **2 local meetings** to tell nearby residents about the plan before the farm was built and how they would benefit from it- these meetings were all **positive with the locals.**
-It was built in a **sparsely populated area** as not to impact on many people.
-This also will help **climate change** and fit in the Kyoto protocol and Paris Climate conference.
-**5 local people are employed** to maintain the turbines and generators
-**No animals were effected** by the wind farm (The site of the wind farm is 80km away from the nearest Important Bird Areas (IBA).
-The **noise level** from the turbines is **below the maximum standard**
-It reduces Uruguay's dependency on fossil fuels
-Projections consider that, at the end of 2016, Uruguay could become the country with the largest energy coverage with wind power

Clean energy investments in Uruguay (in USD)



Disadvantages

-The projection of **shadows** on the houses
-Change in the natural landscape, some argue it is not natural and makes the area look **ugly.**
-The cost of the project is quite high, **148.8 millions dollars**
-Also the company is **privately owned** so they have the power in term of pricing and availability, the sell the energy to the government.

Mitigation – mitigation strategies aim to reduce the cause of global warming by reducing the concentration of greenhouse gases in the atmosphere.

Response to climate change impacts – **global** level (political agreements)

2005 – The Kyoto Protocol – First international treaty – a law. Over **170 countries** agreed to reduce carbon emission s by an average of **5.2% below** the levels for **1990 by 2012.**
Success? Not full compliance from key contributors. USA and Australia refused to sign the treaty.

2009 – Copenhagen – world leaders met to consider international agreements beyond 2012. This resulted in the Copenhagen Accord.
Aims: to reduce emissions, with financial support for LICs (to help cope with the impacts of climate change). But there was no legally binding agreement.
Success? The long term sustainability of this technique was that the focus had shifted to the most vulnerable countries and those least able to protect themselves from climate change. The de-legalisation of the agreement, gave it greater moral and political focus.

Paris agreement (2015) 195 countries adopted the first ever universal and legally binding global climate deal.
Rules:

1. To peak greenhouse gases and achieve a balance between carbon sources and sinks (eg) forests/ ground storage from **2050.**
2. Keep global temperature increase below 2 degrees C and limited to 1.5 degrees C above pre-industrial levels.
3. 3. To review progress 5 yearly.
4. A pledge of US $100 billion a year to support climate change initiatives in developing countries by 2020 (further finance).

Success? More beneficial for LICs than the Copenhagen/ with a five year review targets can be amended/ countries have to think long and short term.

Sustainable – Local/ long lasting/ related to experience and cultural/ not too expensive/ continued by future generations/ doesn't further damage the environment/ build long lasting skills.
Solutions in response to 1.Patterns of rainfall and temperature changing 2. More extreme weather predicted 3. Changing threat of pests and diseases. 4. Sea level rise.

Response to climate change impacts – local level/ sustainable changes

(LIC)Gambia, West Africa – irrigating crops (falsely watering crops)

Solutions –

Introducing drought-resistant strains of crops – This tackles the problem, as droughts will become more frequent.
New irrigation systems – This leads to a wider geographical spread/ more agriculture protected
Educating farmers in water harvesting techniques – This is sustainable as it will be longer lasting and skills can be taught within communities
Shade trees can be planted to protect seedlings from strong sunshine – This is sustainable as desertification and evaporation levels will reduce. More options for water will reduce run off and soil erosion.
New cropping patterns can be introduced eg changing planting/ sowing dates – This make farmers more adapted to less predictable seasonal weather.

Evaluation – The techniques employed in Gambia indicate that farmers are adapting their practice to meet the needs of future conditions. However, investment in water harvesting still will rely on foreign aid and NGO's to fund/ implement.

Himalayas, Asia – Issue= rapidly retreating 16000 glaciers (people rely upon for water supply – a long term threat)

Responses: Creation of artificial glaciers for example in Ladakh village. This involves the collection of water in winter through diversion canals and embankments and it freezes. In spring, when the glacier melts it is a local/ contained water supply.

Maldives, Indian Ocean – 500 km south west of India/ highest point above sea level is 2.4m

Issue: Prediction that by 2030 some islands may be inhabitable due to thermal expansion/ sea level rise and by 2070 submerged.
Response: 1. Building houses that are raised off the ground on stilts. 2. Construction of sea walls (3m sea wall around Male – the capital) and sandbags elsewhere. 3. Construct artificial islands up to 3m high and relocation. 4. Relocate population to Sri Lanka/ India. 4. Restoration of coastal mangrove forests – trap sediment/ protect from storm waves.
Evaluation- The above solutions depend on large amounts on ongoing investment/ changing infrastructure. Foreign aid will need to assist/ uncertainty remains despite this, depending on extent of sea level rise. This is therefore less sustainable than Gambia and Himalayas.